

REMARKS

In the outstanding Office Action, the Examiner has requested to correct any possible minor errors of which applicant may become aware in the specification. In this respect, line 26 on page 26 of the specification has been amended so as to correct such minor error.

In the Office Action, the claims have been rejected because the language "capable of" is not positive claim language. In the Response the claims have been amended to alleviate this problem.

As to the Examiner's question, what is considered to be "biomass", her attention is referred to lines 6 and 7 on page 7 of the present continuation-in-part application. It has been indicated there that "Such biomass coal may constitute, for example, charcoal which is obtained from wood harvested from a forest area." It is absolutely clear to any person skilled in the art how to harvest wood from a forested area.

The Examiner has also requested to qualify how the biomass coal is converted into energy. There are several ways of carrying out such energy conversion disclosed by the application. For example, it has been indicated on

line 11 on page 8 of the present continuation-in-part application that one of the methods for such energy conversion is combustion. On the other hand, the biomass can be converted into energy by hydrogen combustion after producing hydrogen, according to the reactions set forth on page 11 of the application.

It should be noted however, the essence of claim 7 is not about the conversion of energy. There are many conversion methods which will serve the purpose. The basic idea of claim 7 is to provide a method which on one hand, reduced the CO₂-content in the atmosphere and on the other hand provides an energy source. This can be achieved by using one fraction for storing and the other fraction for combustion or converting it into a combustible energy source. In other words: for each combusted amount of coal there is a certain amount of coal stored away to reduce the CO₂-content in the atmosphere. Obviously, the separated fraction has to be limited in order to reduce the CO₂-content in the atmosphere.

The conversion into hydrogen as energy source has the advantage, that hydrogen is lightweight with high energy content-weight and therefore reduces the energy used for transportation (a car has a smaller energy consumption if only little fuel is in the tank). Hydrogen is, therefore, a preferred option.

In the outstanding Office Action claims 1-36 have been rejected by the Examiner under 35 U.S.C. 112, second paragraph as being indefinite. In this respect, the Examiner requires clarification on how the steps of producing photosynthetically an amount of biomass capable of forming biomass coal and harvesting this biomass has to do with the remaining steps of the claims.

The step one of independent Claim 1 refers to "producing photosynthetically an amount of biomass capable of forming biomass coal".

Producing photosynthetically an amount of biomass....relates to the process in which a biological organism is exposed to solar energy in the form of solar radiation which is emitted by the sun and penetrates the atmosphere. During the same time period, the organism is also exposed to carbon dioxide which is present in the atmosphere. Under the action of solar energy (in the form of solar radiation) in the presence of atmospheric CO₂ the process of "assimilation" ensures which the carbon dioxide is converted by the biological organism into carbon-containing compounds. As a result, the biomass of the organism grows by means of this CO₂ assimilation process.

Of the many thousands of examples for this process, therefore may be recited the growth of micro-organisms like photosynthetic bacteria or algae as well

as the growth of macro-organisms like plants such as potatoes or the wood of trees.

Consequently, and by referring back to the object of the invention, the photosynthetic formation of biomass constitutes a process for removing undesired CO₂ from the atmosphere or, in other words, reduce the atmospheric CO₂ level.

According to the step two of independent claim 1, the photosynthetically produced biomass is harvested. Therefore, the growing and harvesting of biomass produced by CO₂ consumption under the action of solar radiation, i.e. solar energy, constitutes a process of storing solar energy because the energy of the solar radiation is used for producing the harvested biomass.

The step of regrowing of the harvested biomass recited in the independent Claim 1 constitutes a process by means of which the atmospheric CO₂ level can be repeatedly reduced as a result of the ongoing regrowing and harvesting process steps.

The repeated growing and harvesting steps (theoretically) would result in an ongoing reduction of the atmospheric CO₂ level provided the biomass, which is obtained as a result of each harvesting operation, can be stored indefinitely for very long times. However, the thus obtained biomass (which contains an amount

of carbon compounds corresponding to the amount of CO₂ removed from the atmosphere) is obtained in an undesirably high volume. Additionally, such biomass is subject to microbial and other oxidative degradation processes which ultimately result in the emission of CO₂ to the atmosphere. At the end of such degradation the emitted amount of CO₂ will correspond to the amount of CO₂ which originally was removed from the atmosphere by the assimilation process. Therefore, the process steps 1 to 3 of claim 1, while based on the use of solar energy, would turn out to be unsuited for ultimately reducing the atmospheric CO₂ level.

In order to overcome this problem, the fourth step of converting has been provided in claim 1.

According to this step, the harvested amount of biomass is converted into biomass coal such as, for example, charcoal in the event that the biomass is wood produced from trees. Accordingly, the method of the invention results in a tremendous advantage with respect to (a) the reduction in the volume of the matter to be stored and (b) the degree to which the stored material is subject to oxidative degradation. Also, in comparison to the harvested biomass, the relatively smaller amount of biomass coal obtained therefrom, still corresponds to the amount of carbon dioxide which was removed from the atmosphere in the assimilation process of step 1 of claim 1.

Also, since the charcoal essentially consists of the carbon which was present in the harvested biomass, there is not only obtained a renewable energy source by means of the repeated growing and harvesting processes, but also a renewable energy source which provides a much higher combustion value per unit weight as compared to the original biomass. Consequently, for generating a predetermined amount of energy, the amount of biomass coal will significantly lower than the amount of biomass.

The obtained biomass coal constitutes a renewable, valuable energy source in which there is stored the solar energy required for growing the biomass which is converted into the biomass coal. The biomass coal is obtained in a sequence of growing, harvesting and converting operations and, as a consequence, the biomass coal is produced with concomitant reduction in the atmospheric CO₂ level.

Further regarding claims 7 and 23, reference is specifically made to the fact that merely a separated fraction of the biomass coal or, respectively, charcoal is converted into energy or an energy source. Correspondingly, claims 10 and 14 specifically are directed to converting a retrieved fraction of the stored biomass coal. Likewise, claims 26 and 30 are directed to a retrieved fraction of stored charcoal which retrieved fraction is converted into energy or any energy source. Therefore, these claims are still believed to be acceptable, because only a fraction

of the biomass coal is further reacted in this manner so that the non-retrieved or main amount of the biomass coal or charcoal is retained and thereby suffices the requirement of storing solar energy. The general term "storing solar energy" in claim 1 is not affected thereby because claim 1 does not specifically require the "entire amount of solar energy" to be stored nor can it be read as requiring that the entire amount of solar energy is stored.

The invention is related to the following essential issues:

- (1) the undesirably high amount of atmospheric CO₂ which is said to arise from increased CO₂ emission into the atmosphere and to cause harmful environmental effects due to the increase in the atmospheric temperature;
- (2) the undesirably high CO₂ emission is said to be caused by increased energy generation from increased combustion of fossil, non-renewable carbonaceous fuels;
- (3) the unavoidable decrease in the available amount of fossil fuels and the expected increase in the unit price of such fuels.

The invention constitutes a two-pronged attack on these problems by, firstly, reducing the atmospheric CO₂-level and sustaining the same at a permissible level and, secondly, using a non-fossil, renewable fuel for generating energy in a way such that the emission of CO₂ is maintained at reduced values

which are tolerable with respect to the atmospheric CO₂ level and the climate situation and which also satisfy present and future energy requirements.

Regarding tree plantations, such convert atmospheric CO₂ by assimilation under the action of sunlight into wood whereby removal of atmospheric CO₂ will exceed by far the removal effectable by any other means. As explained in the paragraph bridging pages 7 and 8 of the CIP application, such removal results directly from tree growth during each vegetation period of growth time. Therefore, continued growth of trees will continually remove CO₂ from the atmosphere.

While the produced wood may be considered to constitute a non-fossil, i.e. renewable carbonaceous fuel, there are two reasons why the intended purposes will not be satisfied by the harvested wood because:

- (i) it will be apparent that the combustion of wood is not economic because of the low amount of energy produced by wood combustion, namely a mere 16.5 MJ/kg (Brockhaus Encyclopedia 2001, vol. 3, page 704) and
- (ii) the combustion of wood will produce CO₂ in an amount which is basically the same amount as the amount of CO₂ which has been removed from the atmosphere by the growth of the harvested trees. It should be noted that the presently much ballyhooed agriculturally produced so-called biofuels like bioethanol, biodiesel, etc. have exactly

the same disadvantage, namely the respective plants, too, grow by assimilation of atmospheric CO₂ under the action of sunlight and further processing and the biofuels are obtained by further processing of the harvested plants. The combustion of such biofuels thus will likewise result in the return of the prior assimilated CO₂ into the atmosphere. In the end, and as the case of wood, production and combustion of such non-fossil, renewable fuels do not and cannot result in a meaningful reduction in the level of atmospheric CO₂.

Further regarding wood, this has a further disadvantage in that it is not resistant to degradation and its storage would require comparatively large space. Converting wood into charcoal results in a material which not only can be stored without degradation, particularly upon exclusion from air, but requires much less storage space than wood. In particular, charcoal not only generates comparatively high amounts of energy upon combustion but furthermore can be converted in known manner into a high energy fuel.

Thus, while constituting a carbonaceous material, charcoal constitutes a non-fossil, renewable energy source which is annularly available by wood-harvesting from tree plantations.

Regarding the high energy fuel, charcoal can be converted into hydrogen which, upon combustion, does not emit CO₂ but merely harmless water. On first sight, therefore, combustion of hydrogen has two tremendous advantages in comparison to presently used fossil, non-renewable fuels: (1) combustion of hydrogen generates much more energy per unit weight than fossil carbonaceous fuels and (2) hydrogen combustion as such does not contribute to the atmospheric CO₂ level:

1 kg of hydrogen, upon combustion, generates 141.8 MJ of energy (Brockhaus. 1.c., vol. 22, p. 614). The hydrocarbon octane, a typical conventional, fossil and non-renewable motor fuel generates a combustion energy of 46 MJ. Thus, when replacing octane (or other current motor fuels and, likewise, heating oil) with hydrogen, the amount of energy generated by combustion per kg, is higher by a factor of 3.08 and, as such, is not unarmful because it does emit CO₂ into the atmosphere. In other words, the combustion energy of 1 kg of octane would be available from 0.324 kg of hydrogen and, additionally, without releasing CO₂ to the atmosphere. Note: According to the stoichiometry, octane of the chemical formula C₈H₁₈ has a molecular weight of 114 and comprises 96 weight units of carbon and 18 weight units of hydrogen, i.e. 84.2% of carbon and 16.8% of hydrogen. Combustion of 1 kg of octane thus will release 3.09 kg CO₂ to the atmosphere. Considering that 3.08 kg of octane are the combustion energy equivalent of 0.324 kg of hydrogen.

Therefore, replacing conventional fossil fuel with hydrogen is highly desirable in view of (i) the combustion energy equivalent weight of a conventional, fossil, non-renewable fuel like the hydrocarbon octane is about three times the combustion energy equivalent weight of hydrogen and (ii) hydrogen produces, upon combustion, merely environmentally totally harmless water.

Regarding the production of hydrogen, the invention relies upon the carbon-to-hydrogen conversion process which is exemplified by CIP example 3 and generally known as such. In fact, the invention relies upon the carbon source of charcoal as obtained from wood which is preferably obtained by sustained forestry.

Two caveats, however, have to be raised:

- (1) As stated on CIP page 12, lines 6 and 7, in respect to equation (1) and its stoichiometry, 16.6% of the carbon undergoing the reaction, will be consumed by combustion in order to provide the thermal energy required for carrying out endothermic reaction 1 of the process,
- (2) As stated on CIP page 9, line 24, the carbonizing process of converting wood into charcoal in the carbonizer according to Example 2 is accompanied by the emission of 0.54 weight units of CO₂ per 1 weight

unit of wood. Thus, a further source of CO_2 has to be taken into consideration when analyzing the hydrogen formation.

Thus, the inventive wood-to-charcoal-to-hydrogen conversion process entails CO_2 emissions which can not be avoided. In fact, in the event, that the entire charcoal is converted into hydrogen, the unavoidable CO_2 emissions from charcoal production and reaction 1 add up to a value which is higher than the CO_2 emission caused by the combustion of the combustion energy equivalent of octane. However, when considering the Examples, it will be evident that the main reduction in the atmospheric CO_2 level removal is effected by storing the charcoal made from wood which has been obtained from tress harvested in tree plantations grown in accordance with the principles of sustained forestry. A net reduction in the atmospheric CO_2 level is, then, obtained provided that the CO_2 released due to conventional hydrocarbons like octane is higher than the CO_2 emission due to the charcoal-to-hydrogen conversion in accordance with Example 3. Or, in other words, provided that the CO_2 emission due to the carbon-to-hydrogen conversion is lower than the CO_2 -removal effected by the charcoal storage according to Example 2. This is, in fact, realized in Example 3 by producing hydrogen from a sufficiently lower amount of the stored charcoal. Merely as an example therefore, 10% of the stored charcoal are introduced into the carbon-to-hydrogen conversion process although higher amounts of hydrogen can be produced without the release of unduly increased CO_2 emissions as long as these emissions do not raise the

atmospheric CO₂ level to values above the level which is maintained by the wood-growing and charcoal forming process.

Applicants have made the best faith effort to place the present application in condition for allowance. However, if any issue raised by the Examiner remains unanswered, she is invited to call the undersigned at the telephone indicated herein below. Early examination of this application is respectfully requested in view of the above Amendment and Remarks.

Applicants respectfully petition for two months extension of time for replying. The respective Petition and credit card payment accompany this Response.

Respectfully submitted,

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